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PRELIMINARY DESCRIPTION AND SPECIFICATIONS FOR A DANISH COASTAL--ETC(U)

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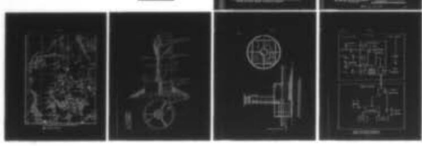

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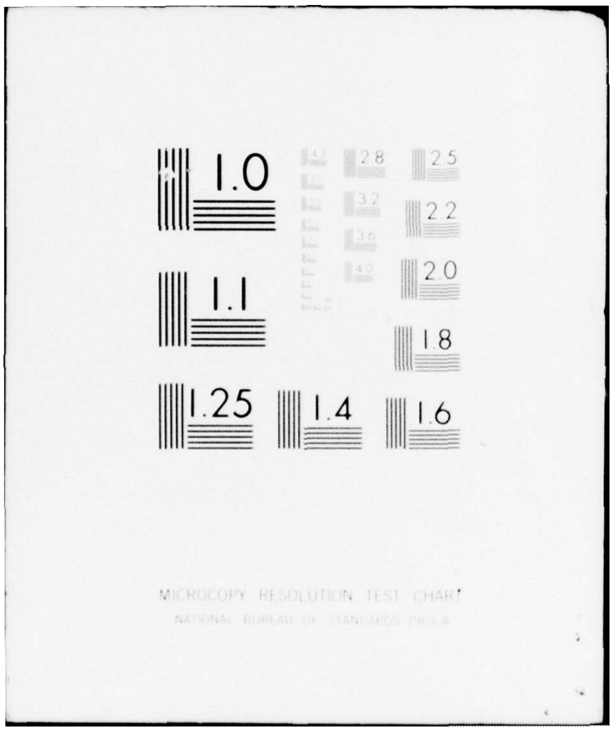
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PRELIMINARY DESCRIPTION AND SPECIFICATIONS FOR A DANISH COASTAL MARINE DATA COLLECTION SYSTEM

LCDR JOHN P. SIMPSON, USN*

25 JULY 1977

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UNITED STATES OF AMERICA

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER R-7-77	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Preliminary Description and Specifications for a Danish Coastal Marine Data Collection System		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER R-7-77
7. AUTHOR(s) ~~LCDR~~ JOHN P. SIMPSON USN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Naval Research, Branch Office, London Box 39, FPO New York 09510		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS ONRL-R-7-77		12. REPORT DATE 25 JULY 1977
		13. NUMBER OF PAGES 12
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 16p.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

6 10 14 11 12

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

To an increasing extent Denmark is faced with a series of problems linked with the safe navigation of large and deep draft ships through the Danish waters. This is particularly important in the narrow and shallow fairways of the Baltic approaches where the waters have a transient nature because of their position between the fresh Baltic and the saline Kattegat. Instantaneous sea level, sea state, current, sound speed, ice probability and buoyancy are among the factors to be considered when navigating the Danish straits. The

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20. (Cont) Royal Danish Administration of Navigation and Hydrography has undertaken the job of developing a system to measure or compute these parameters, providing "real-time" oceanographic data to transiting ships.

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PRELIMINARY DESCRIPTION AND SPECIFICATIONS FOR A DANISH MARINE COASTAL DATA COLLECTION SYSTEM

CONTENTS

PRELIMINARY DESCRIPTION AND SPECIFICATIONS FOR A DANISH MARINE COASTAL DATA COLLECTION SYSTEM

by

LCDR JOHN P. SIMPSON, USN

INTRODUCTION

The increased size and draft of today's new ships has prompted the Danish Department of Commerce to take certain precautions regarding the security of passage of these large ships through the precarious Danish straits. One of these precautions involves supplying the ships with real-time information on navigational conditions in the more restricted and shallower waters. The Royal Danish Administration of Navigation and Hydrography (RDANH), as a result of its background of involvement with navigational safety, has undertaken the job of providing the pilots of large tankers and bulk carriers with real-time oceanographic information on water level, current, waves and other physical properties of the water at particularly sensitive areas along the so-called "Transit Route" (T-Route).

The project started modestly (Phase I) with manual readings of water level at a number of harbors located along the T-Route. When water level information is required, the watch officer at a central station telephones to the appropriate harbors, where previously designated individuals are assigned the responsibility of obtaining the desired data at predetermined intervals and sending it, via telephone, back to the central station. One of the primary faults of the system is its dependence on the "human link" who is often a shop owner or harbor official with numerous other responsibilities.

In Phase II (scheduled for completion in 1977) the "human link" will be eliminated by combining a telephone call-up system with a water level measuring device. This device is a conventional float-type tide gauge with an 11-bit parallel binary-code output and an internal digital display that allows calibration on the spot. The coded output will be connected to a telephone transmission system manufactured in Denmark.

The central station, located in Fornaes (see Fig. 1), can receive real-time data by simply initiating a call to the desired data collection station. Water level and a station identifier will then be displayed and printed at Fornaes automatically. Further dissemination of the data will be the responsibility of the officer on watch. In order to reconstruct specific circumstances and to obtain data for future numerical models, each tide gauge will be equipped with a tape-recording device capable of logging the water level four times per hour (tape renewal every six months).

A disadvantage of both Phase I and Phase II is the location of the sensors themselves. Oceanographic conditions along the T-Route will not always be reflected by measurements taken in nearby harbors. In Phase III of the project, the sensors will be deployed from lighthouses located directly alongside the T-Route. Fig. 1 shows the proposed locations of these lighthouses and of other light structures which, because of their navigational importance, may also be sensor equipped. Preparations for Phase III have already begun. This paper, as a step in that preparation, is designed to give potential contractors and vendors background information on the project and general specifications adequate to estimate feasibility and cost of construction.

OBJECTIVES

From the Danish Department of Commerce circular of 30 January 1976, concerning the navigation of large ships through Danish water: ". . . In order to further secure the navigation of large ships, a radio information service is established. This service has as its goal . . . to inform (large ships) on variations from the normal of current, water level, and wave conditions. . . ." The practical objective is to have real-time data on the aforementioned oceanographic conditions available so that: (a) normal conditions can be more precisely specified, and (b) variations from the normal can be determined and, on a real-time basis, be sent to the ships about to sail through the critical areas.

The Danish Weather Service, in an effort to increase synoptic coverage and augment the knowledge available on the local marine environment, has also expressed interest in utilizing these lighthouse data stations. As a number of meteorological parameters (for example, visibility and wind conditions) have a direct effect on navigational safety, it is hoped that at least some of the data collection stations will be equipped with both meteorologic and oceanographic sensors. The secondary objective, then, is to build a data collection network capable of expansion to include both sets of environmental parameters.

Concurrent with Denmark's efforts, the Common Market, with augmentation from non-member countries, has begun a project to standardize and utilize marine data collection stations as part of a large European network. The project is called COST 43, and though final approval has not yet been obtained (there is no Danish national funding yet) it is planned that the Danish Marine Data Collection Stations will be compatible with and form part of the European network.

As a step in this direction, the RDANH plans to use the sensor test station at Laesø Rende lighthouse in the northern Kattegat as a preliminary COST 43 data collection station.

STATION DESCRIPTION AND SPECIFICATIONS

Physical Limitations

A total of seven stations are now being considered for configuration as data collection platforms (see Fig. 1). These lighthouses are either completed or are planned for completion by 1981. Four of the stations will be located on platforms similar to that shown in Fig. 2. This typeof structure will not be connected by cable to land. The light itself is gas driven; any other power consuming equipment must be provided with its own power supply (nominally batteries).

The remaining lighthouses will be similar to that shown in Fig. 3, with exact size and configuration differing from lighthouse to lighthouse. These three structures will have 220-V, 50-Hz electrical power available. The lighthouse at Drogden has a telephone connection to land, while the other two, near Anholt and at Sjaellands Rev, will be equipped with a UHF lighthouse control system, one channel of which can be made available for transmission of environmental data.

The central station, in addition to handling the environmental data, will be equipped as the master station for control of the large lighthouses. It will also control the four Phase-II stations previously mentioned. Fornaes (the central station) has no computer facilities.

Sensors

In order to meet the primary objective of the system, the following oceanographic parameters must be measured:

Current speed Current direction	at 2 levels
Water level Wave activity	from water surface
Temperature Salinity	at 2 or more levels

To facilitate ease in handling, each sensor system must be constructed so that only the sensor itself will be placed in the water. Resistance to fouling is of prime importance as is minimal drift. Sensors may be left unattended for as long as three months (though monthly visits are planned during the summer season to remove fouling organisms). A short discussion of individual sensor requirements follows:

Current meters. The extremely fast fouling rate that exists in the shallow Danish waters necessitates selection of a current meter with no moving parts (conventional rotor/propeller types can be completely out of calibration within two weeks). Large mechanical-vane types are out of the question because of their weight and inherent difficulty in transmitting real-time data. It appears, therefore, that an electromagnetic or an acoustic type will be chosen, with the final decision depending on the sensor's resistance to fouling and its degree of drift. Required accuracy for this sensor is ±5-10 degrees in direction and ±0.25 kt in speed.

Water level. Although the conventional float-type sensor has many desirable qualities, the formation of ice complicates its use in unprotected waters. Intentions are to employ a differential (air-pressure compensated) type pressure sensor. At those lighthouses where such a system is inadvisable, a regular pressure sensor will be used, with variations in air pressure registered by an installed barometer. Accuracy of this system should be within 2 cm.

Wave activity. Wave-riding buoys are very popular in Denmark, but they are both expensive and susceptible to damage by ice. Wave staffs are also vulnerable during ice winters. Acoustic devices, though attractive, are generally too expensive and perhaps too bulky to deploy from the small lighthouses. Pressure sensors appear to be the best suited to the environment, and in fact, one sensor might be adequate for computing both wave activity and water level. It should be noted here that whatever sensor is chosen, its ultimate measurements should probably be significant wave height and period. The data should undergo some processing prior to transmission to the central station. Required accuracy for wave height is ±5 cm.

Temperature and salinity. The most desirable solution to the problem of obtaining temperature and salinity data would be to have a temperature/salinity (conductivity) chain with sensors spaced about a meter apart. In the absence of such a chain, the requirements of the system could probably be met with two levels of T/S sensors. Accuracy is not critical, but should be within ±0.5°C, and ±1 ppt. Length-of-time constant is not particularly significant.

Whatever the final selection for a sensor suite, considerable effort should be expended to mount them so that they are adequately protected from drifting and fast ice, and so that they can be serviced or replaced without the use of divers. It is absolutely imperative that the water-level sensor functions year-round. It is conceivable, though not desirable, that the other sensors could be removed when ice threatens.

The exact suite of meteorologic sensors to be deployed on the lighthouses has not, as yet, been determined. Sensor specifications and mounting requirements will be worked out by the Danish meteorologic community in due time.

SYSTEM CHARACTERISTICS

Sensor Inputs to the System

The transducers within sensors provide electrical signals that are constrained by the method chosen. In most cases these signals have to be conditioned to make them compatible with the data-acquisition system. If conditioning is achieved within the sensor, signals can be accepted directly into the data-acquisition system. If this is inconvenient because the environment is adverse or because there is insufficient space in the sensor, interface modules must be provided as a part of the data-acquisition system to condition the sensor signal. The sensor or sensor interface should then provide signals in one or more of the following forms:

- Analog -5 to +5 V dc*
- Pulse trains
- Digital BCD codes
- Current input, industry standard, but signals to be conditioned to produce voltage levels between -5 and +5 V.

Data Acquisition and Collection Subsystem

The functions of this subsystem shall include: The rapid scanning of the sensor outputs, conversion of signals to acceptable communication codes, and temporary (for further transmission) and permanent (for historical records) storage of the data. Interrogation of sensors (scanning) shall be initiated by internal clock and/or by external source.

The basic system must be equipped with the number of channels adequate to handle a complete sensor array in an expeditious manner. The output should be a synchronous transmission containing address, data, and error detected code. It is highly preferred that the central station has the capability of interrogating each sensor station independently.

The system should be compatible with standard meteorologic transmission codes (for example transmission interfaces to CCITT specification V 24 and communications code CITT codes 2 and 5*).

*From COST document 64/76.

Transmission and Receiving Subsystem

The subsystem should be compatible with the aforementioned codes. The proximity of the sensor stations to land, points toward the use of a combination telephone/radio link, except in the case where transmission lines are already established. It is envisioned that the call-up procedure will be similar to that for Phase II, with the officer on watch initiating the measurement by calling, via telephone, previously specified numbers. The receiving equipment shall then be able to receive the codes sent and interface, further, to a minicomputer or a microprocessor.

Processing and Display Subsystem

The selected processing subsystem, in addition to interfacing with the receiving system, shall be capable of automatically converting various coded values to usable engineering units--for example: Current direction and speed (in degrees and knots), water level (as over or under a given null), wave height (significant height in tenths of meters), wave period (in seconds), temperature (in degrees Celsius), and salinity (in parts per thousand).

The converted data should then be displayed, printed or recorded and, if required, sent further via telex to a selected weather central. The required information will thus be available for the watch officer to send via radio to transiting ships.

It is expected that sensor stations will not be interrogated from Fornaes on a regular basis, but only as the need arises. Under these circumstances, the meteorologic community may deem it feasible to establish their own interrogation system. An interrogation schedule could then be established to prevent interference.

EQUIPMENT CONSIDERATIONS

Power Requirements

The remote stations must be capable of operation without maintenance visits for a period of from three to six months. The electrical supply will presumably be batteries, but thermo-electric or wind generating devices may be considered. Mains voltage will be employed at the receiving station.

Environmental Operating Limits

Remote stations should be capable of operating satisfactorily throughout the temperature range of -15° to +45°C. The equipment should be able to survive, without damage, temperatures from -30° to +45°C. All field equipment shall operate satisfactorily

throughout the ambient humidity range of 10 to 100%. The equipment shall: Operate satisfactorily in hf fields produced by other equipment, survive vibration spectra associated with delivery by mail, road, and small boat satisfactorily, and be protected against the effects of lightening. Central receiving, computing, and display equipment shall be compatible with the normal office environment.

Testing

The equipment should be constructed so that it may be assembled and tested in an office environment prior to deployment on the lighthouses. Sensor and system testing (with limited calibration) on the lighthouses is an absolute necessity.

Construction

Equipment construction should be of high engineering standards, with MTBF of not less than 1,000 hours. The use of high-quality connectors is justified. Sensor cables should be unpluggable from the data acquisition unit to facilitate easy replacement. Individual sensor failure must not cause system failure. All associated equipment manuals, including lists of spare parts, should be provided in Danish and/or English. Where a magnetic-tape datalogger is used, the data written on the tape should be *FCMA 34 standard, encoding following ECMA 6.

As ice formation is not unknown in these waters, the sensor mountings should be constructed in such a manner as to be minimally affected by ice formation and movement. Sensor positioning should be such that replacement or cleaning can take place without the use of divers.

Simplicity in design and function must be stressed. Some requirements may be reduced if such a reduction will significantly increase simplicity and reliability.

SYSTEM IMPLEMENTATION AND FINANCING

A modest amount has tentatively been budgeted for this project over the next three years. Should the proposed budget become a reality, the purchase of the central station equipment will assume first priority, with sensor stations being equipped as funds become available.

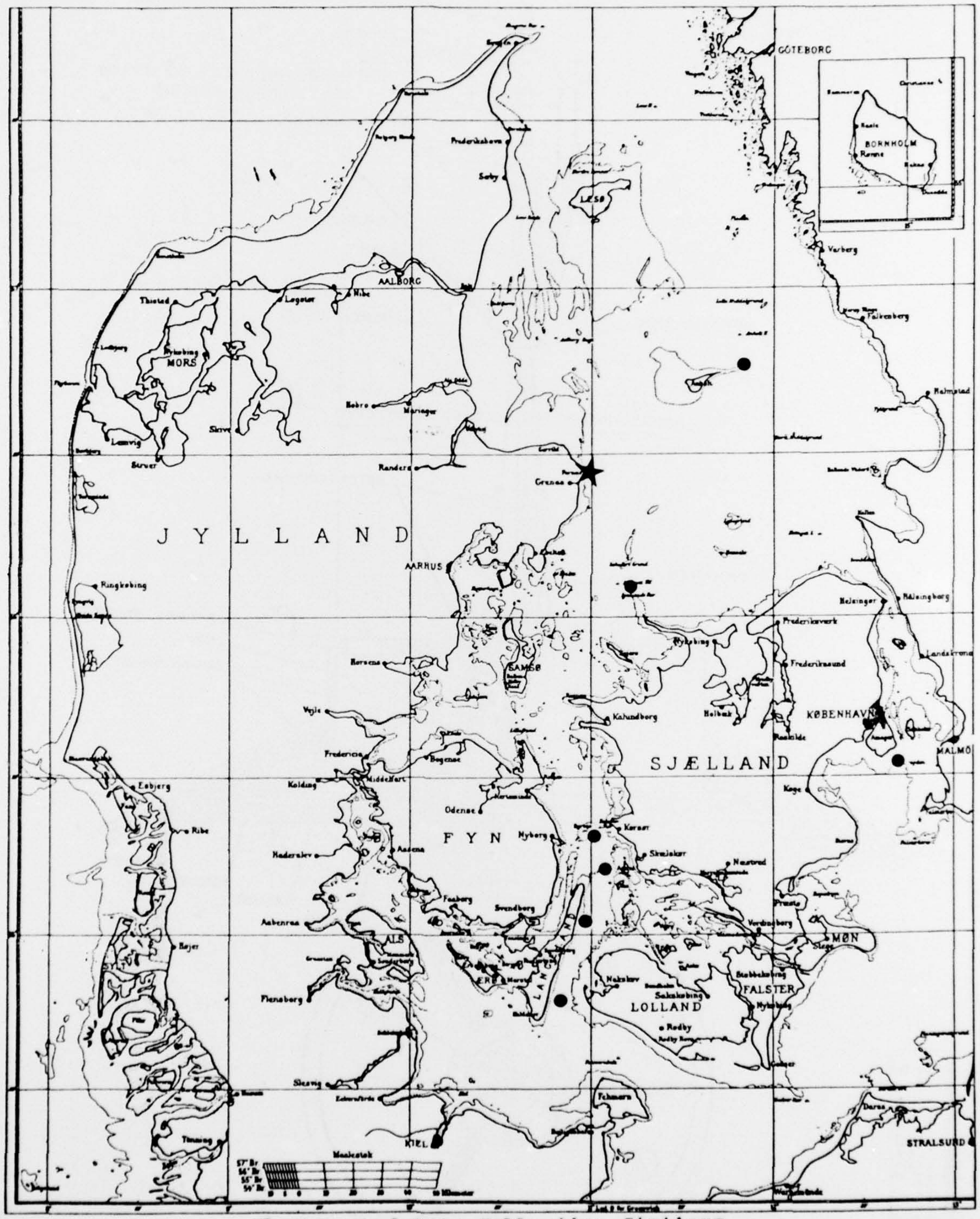
*From COST document 64/76.

The very nature of the project dictates the use of high-quality equipment, especially at the sensor stations, where maintenance visits are difficult to arrange. As the funding will be somewhat limited, consideration should be given to developing an inexpensive system which is simple in design, but utilizes quality components.

Since the sensor stations and resultant data will be used by the meteorologic community as well as the RDANH, it is hoped that an agreement can be reached whereby expenses for mutually used equipment can be shared in an equitable manner.

None of the oceanographic sensors presently under consideration are manufactured in Denmark, and it is thus expected that they will be purchased from various firms in Europe and possibly in America. It is hoped, however, that the remaining equipment, including transceiving systems, data acquisitions systems, and processors, will be produced in Denmark. This will have the double effect of supporting Danish industry, while at the same time simplifying maintenance, installation, and repair problems.

Fig. 1



● Proposed Data Collection Stations

★ Central Station

Fig. 2

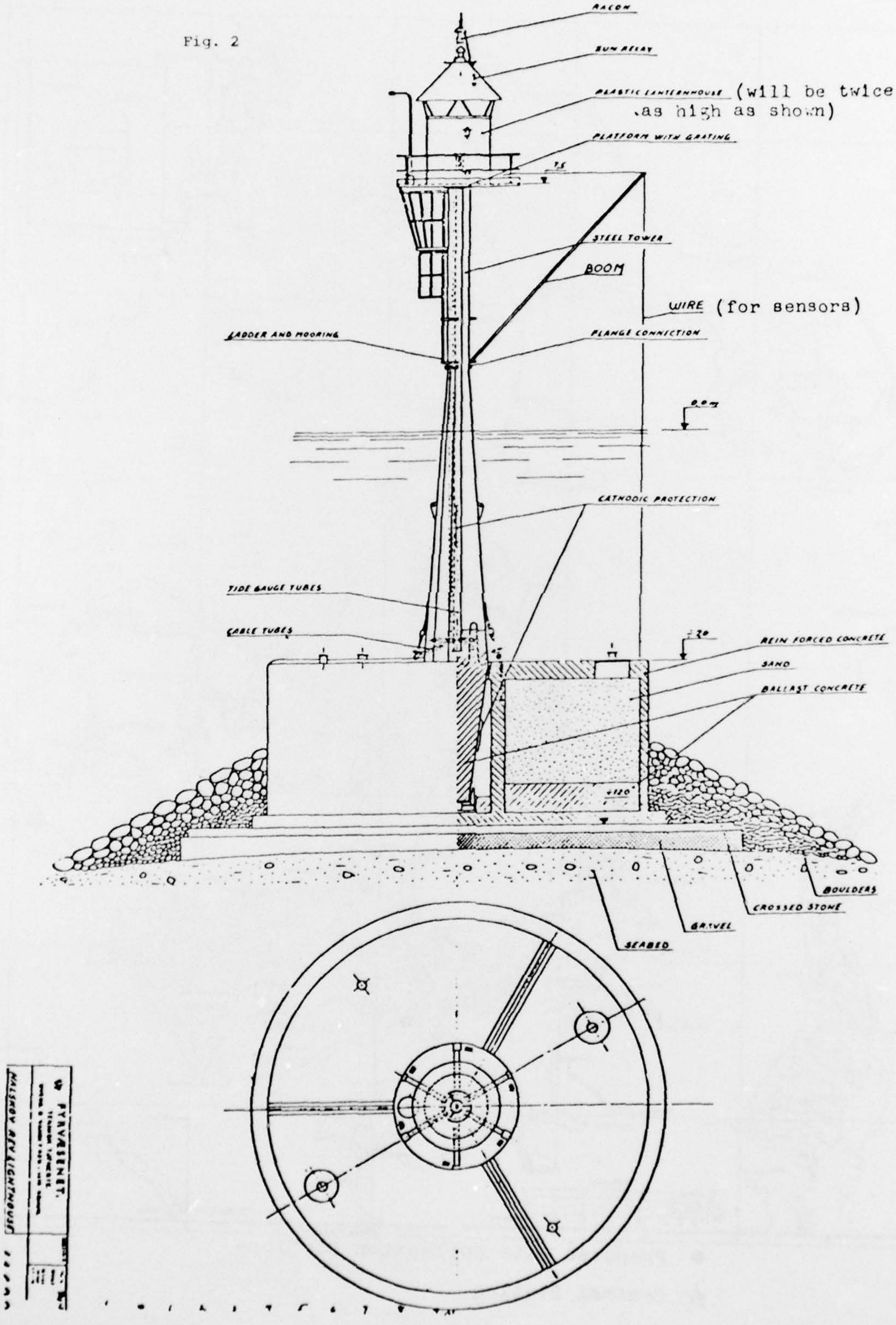
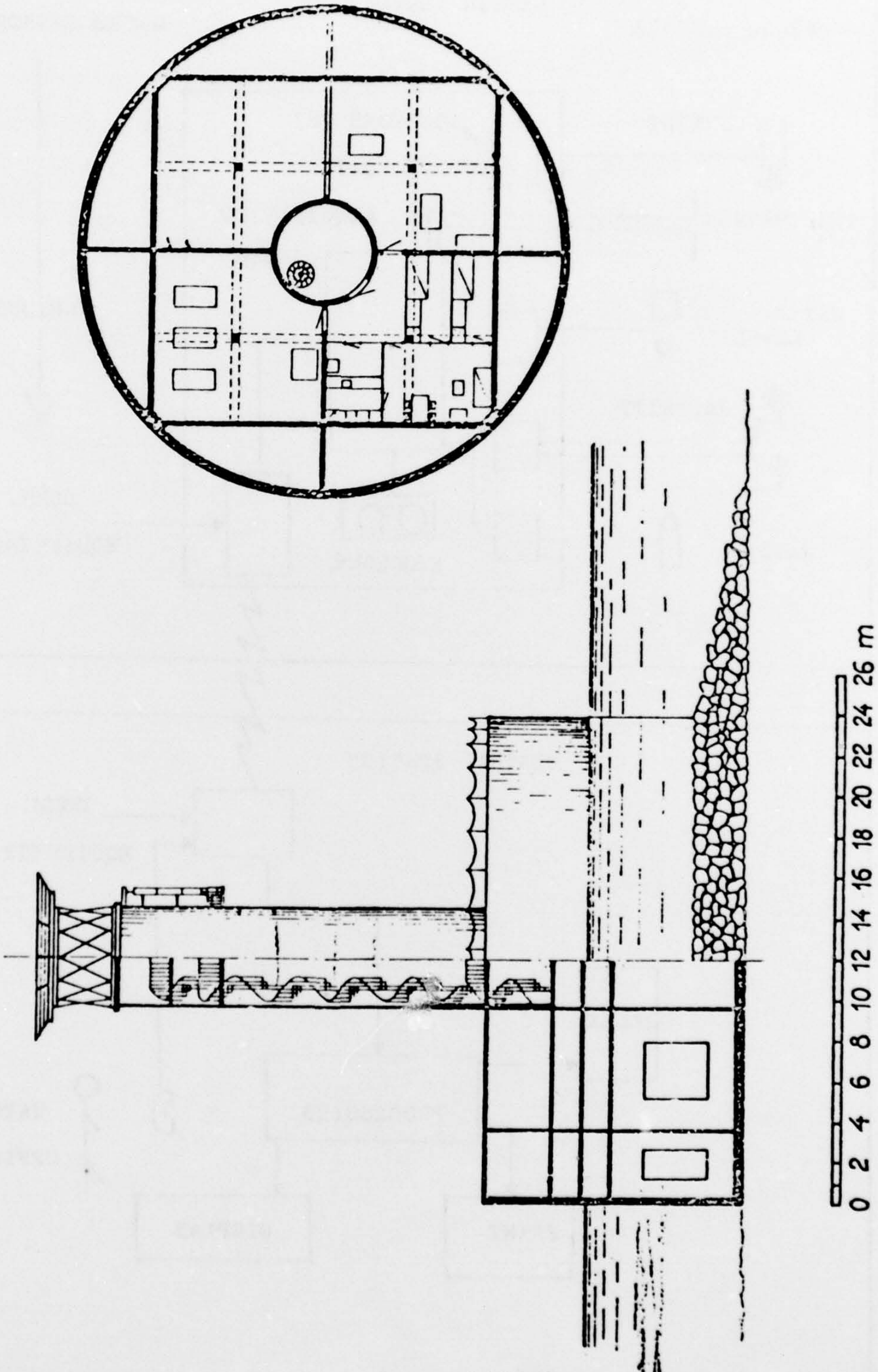
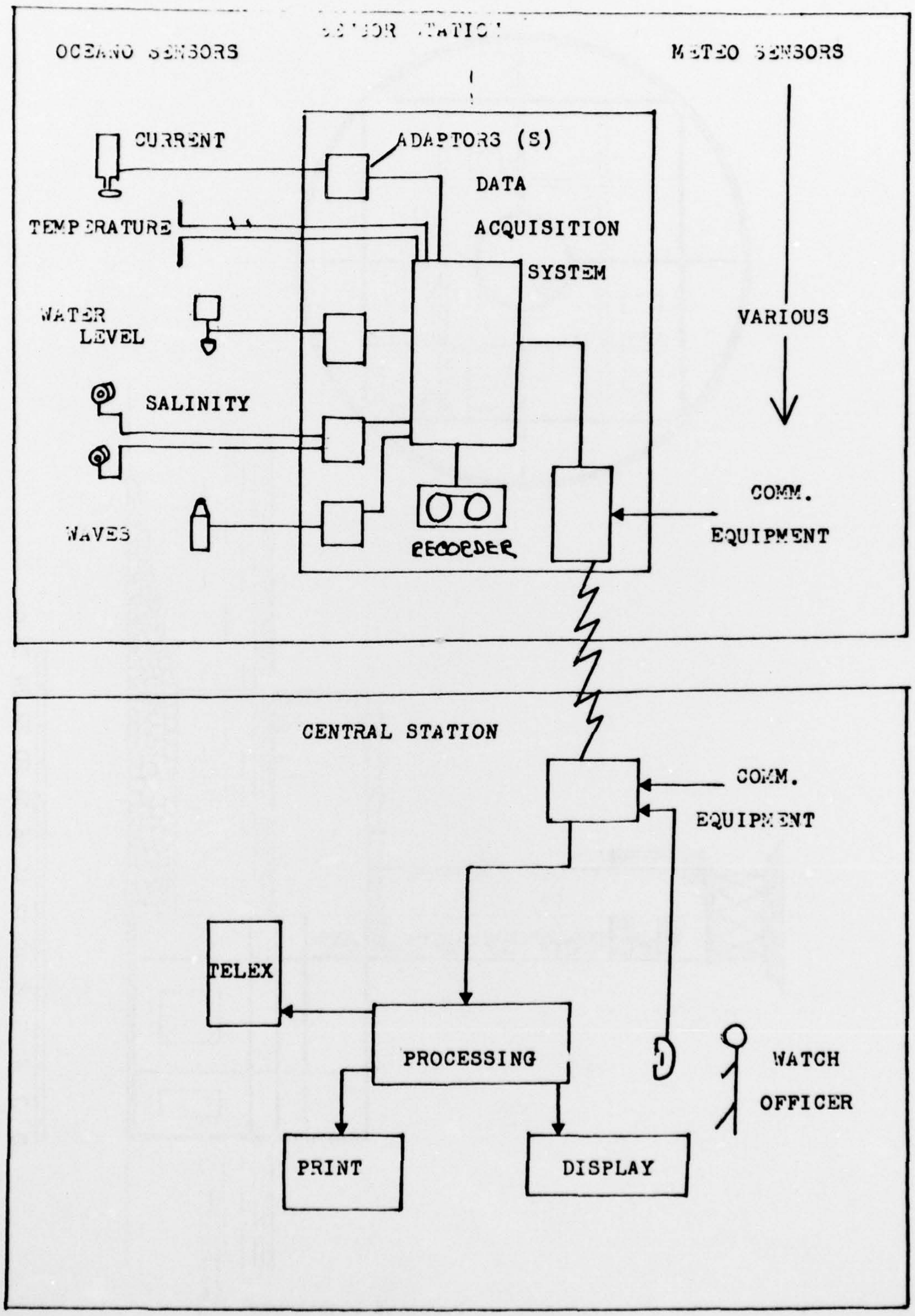

RACON
SUN RELAY
PLASTIC LANTERNHOUSE (will be twice as high as shown)
PLATFORM WITH GRATING
STEEL TOWER
BOOM
WIRE (for sensors)
LADDER AND MOORING
FLANGE CONNECTION
CATHODIC PROTECTION
TIDE GAUGE TUBES
CABLE TUBES
REINFORCED CONCRETE
SAND
BALLAST CONCRETE
BOULDERS
CROSSED STONE
GRAVEL
SEABED

Fig. 3



Proposed Lighthouse



Simplified Block Diagrams of
Sensor and Central Stations